



GUILTY GEAR Xrd Development Staff

Modeling for Skinning



About today's talk



OUTLINE

Proposition: “Are you trying to solve all your skinning problems... with skinning?”

When skinning just doesn't work, the problem often lies in what comes before, modeling, or rigging stages.

A little ingenuity in the modeling stage can make skinning much easier. On the other hand, if the mesh structure is inadequate, no matter how hard you try in the skinning process, you may find that the problem cannot be solved.

In this session, titled "Modeling for Skinning", I would like to introduce some modeling tips to get good skinning results.

Intended Audience: Those who can model the mesh but are not good at skinning. / Those who want to deepen their understanding of skinning.

Speaker Profile

Junya Christopher Motomura



Arc System Works Co.

Lead Modeler / Technical Artist / Various others

I was a modeler and wanted to write shaders, so I became a technical artist.

Modeling, rigging, shader creation, giving talks, etc.

Currently in charge of technical art support and R&D.

Representative Works

⇒ **GUILTY GEAR Xrd Series**

Lead Modeler / Technical Artist

⇒ **DRAGON BALL FighterZ** (Bandai Namco Entertainment)

Director / Modeling Supervisor / Technical Artist

Table of Contents

Part1: Modeling for Easy Skinning

Part2: Behind the Scenes of Skinning for Modeling

Part3: Modeling for Better Joint Deformations

Part4: “Bone Placement” & “Modeling”

Part5: Other Skinning Tips

Part6: Extra - A Basic Introduction to Rigging



About today's talk

Any type of 3D software is acceptable.

As this lecture is a sequel to the previous lecture on "GUILTY GEAR Xrd", Softimage will be used for demonstrations. However, we have chosen tips that can be applied regardless of the software.

For the purposes of this talk, we assume the low-poly model used in real-time.

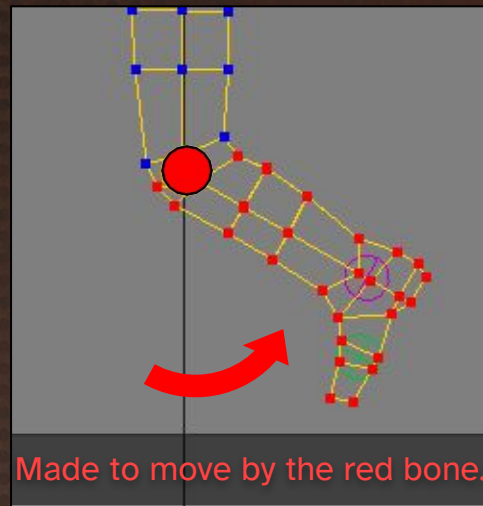
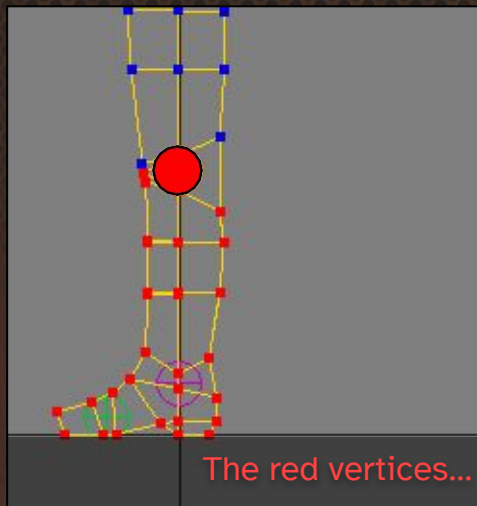
In this seminar, "low poly" is defined as **a model that can be adjusted on a per-vertex basis**, and the tips will be focused on skinning in low poly models.



What is “skinning”, anyway?

Skinning is the process of specifying which vertices are affected by the movement of each bone. Without this, you cannot pose or animate.

For Example:



⇒ Without this, you can't pose or animate.

⇒ To set it up properly, you need to specify the details manually.

(Especially for low-poly)

Part1

Modeling for Easy Skinning



TIPS : Model in a pose that is easy to work with

⇒ You can use either an A-pose or a T-pose. Choose the easier one for your project.

⇒ Whether modeling or skinning, it's important to **make it easy to select the vertices of the mesh**.

⇒ Easy to select the target range = easy to work with.

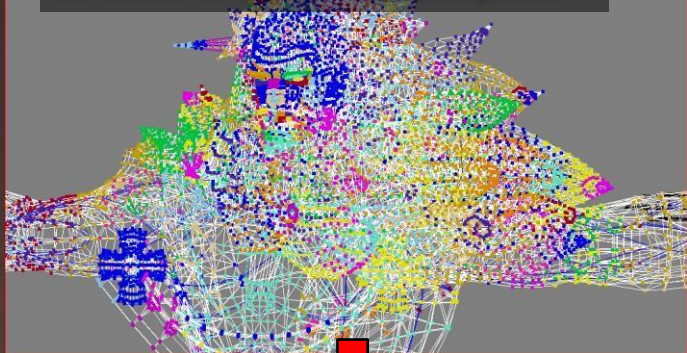
⇒ In theory, any pose is OK, but the T-pose has become a standard as it is easy to work with.

(For example, it would be hard to work with an arms crossed pose, right?)



TIPS: How to split the mesh

If you create everything in 1 mesh, it'll be harder to select individual parts.



Keep everything in smaller pieces.



⇒ Of course, it's difficult to model and skin if the structure is complicated.

⇒ For things that are not obviously connected, it is easier to keep them in separate parts.

⇒ At ArcSys, the mesh is divided into parts, such as hair, clothes, and accessories. (Eventually integrating each material into UE4)

⇒ There are several rules depending on the specifications of the job (game engine, etc.), so make sure to check beforehand.

(In terms of processing load, it is more advantageous to have them all together in the end.)

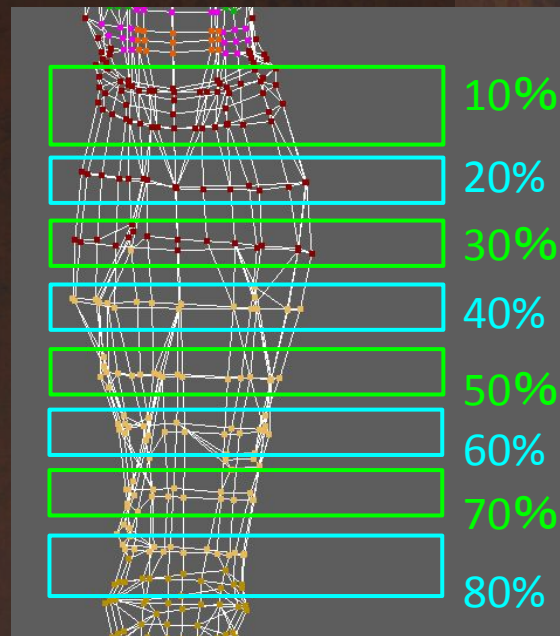
TIPS: Arrange the Vertices Neatly

⇒ There are many cases where you want to set weights in a gradient fashion. (Such as.. increasing the weight by 10% for each row)

⇒ For such cases, **it's recommended to have the vertices aligned in a loop**, so that the same weight can be set.

⇒ If the vertices are placed in a disorderly manner, you'll increase the time and effort required for manual weighting.

⇒ However, this is not absolute. Adding more vertices just to maintain a loop structure may have negative effects. (We'll come back to this.)



If the vertex arrangement is clean, managing them becomes easy.

Part2

Behind the Scenes of Modeling for Skinning

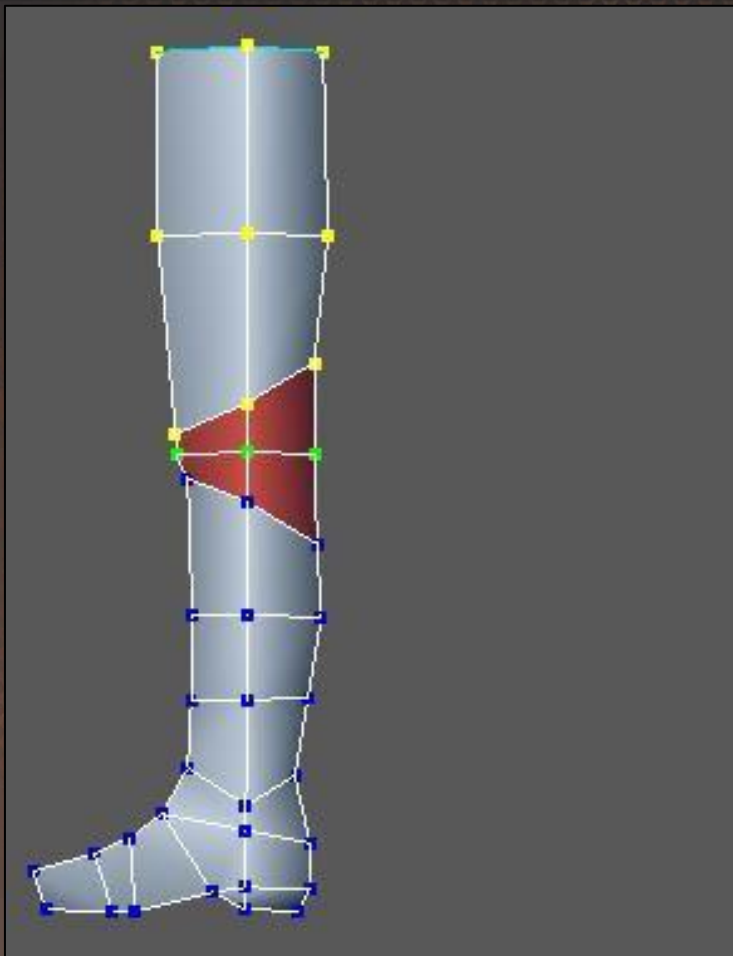


Common Misconceptions

“If I just increase the number of polygons and skin it nicely, the joints will bend well.”

- ⇒ This is a trap that beginners tend to fall into.
- ⇒ It leads to bad results, at least in low-poly models for real-time use
- ⇒ For experienced users, pursuing the “why” will deepen their understanding, so I would like to delve into this topic.
- ⇒ Honestly, if this is all you remember from this talk, it will have been more than half successful.

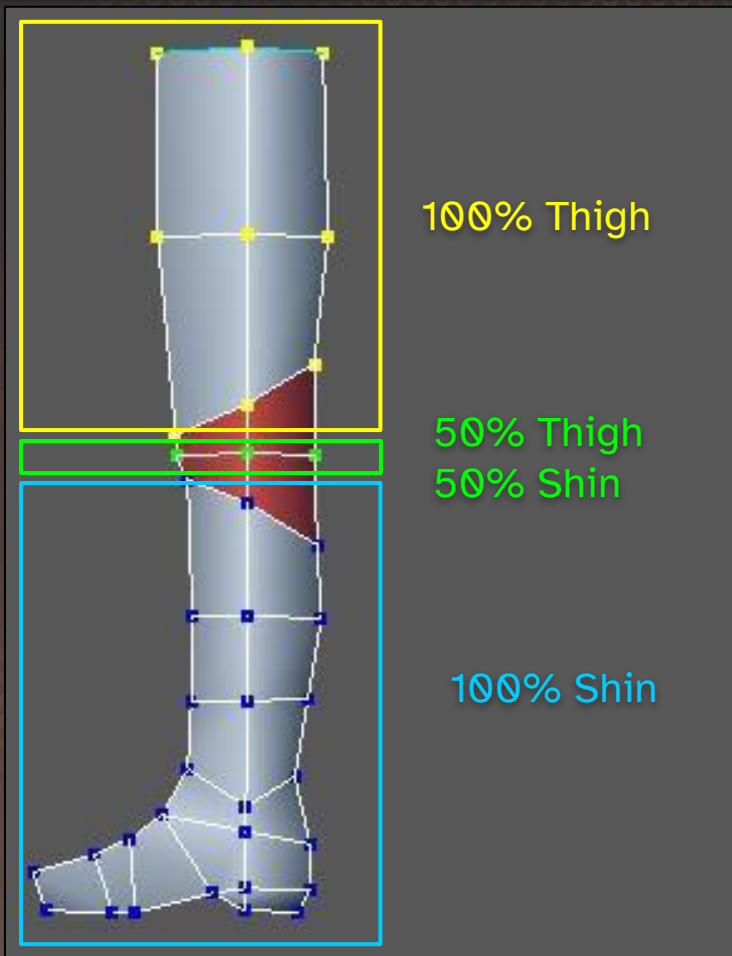
Joint Modeling : Common Mistake – The “50% Trap”



**An easy-to-understand example,
how skinning tens to be
structured around the knee.**



Joint Modeling : Common Mistake – The “50% Trap”



An easy-to-understand example, how skinning tens to be structured around the knee.

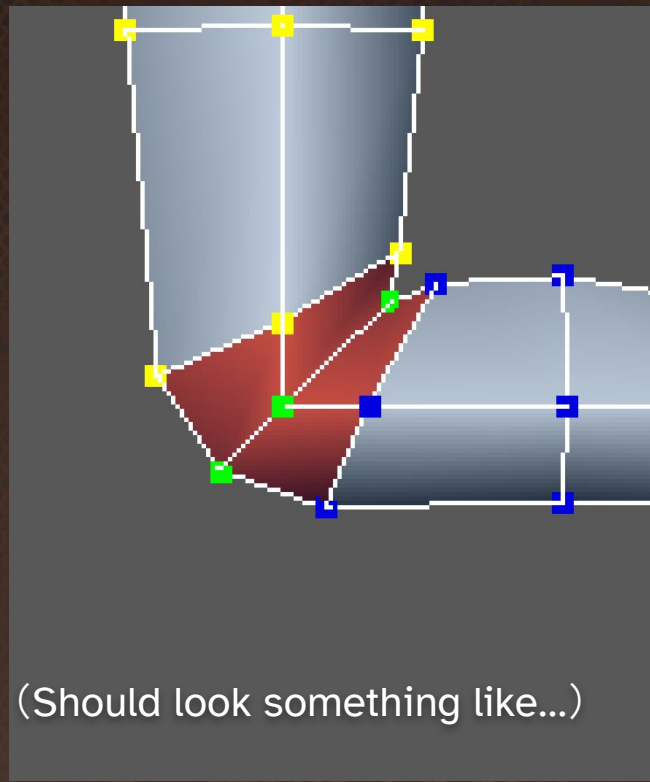
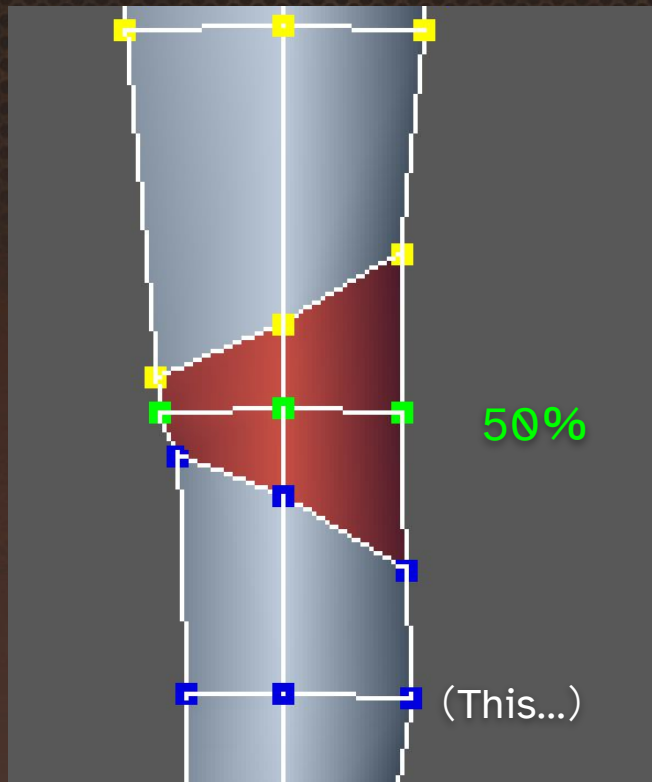
⇒Thighs and Shins, they each have a range assigned to them, at 100% weight.

⇒The vertices near the knee, in the middle of the range, have a 50% of its weight allocated to each of the thigh and shin.

At first glance, this seems like a good idea...

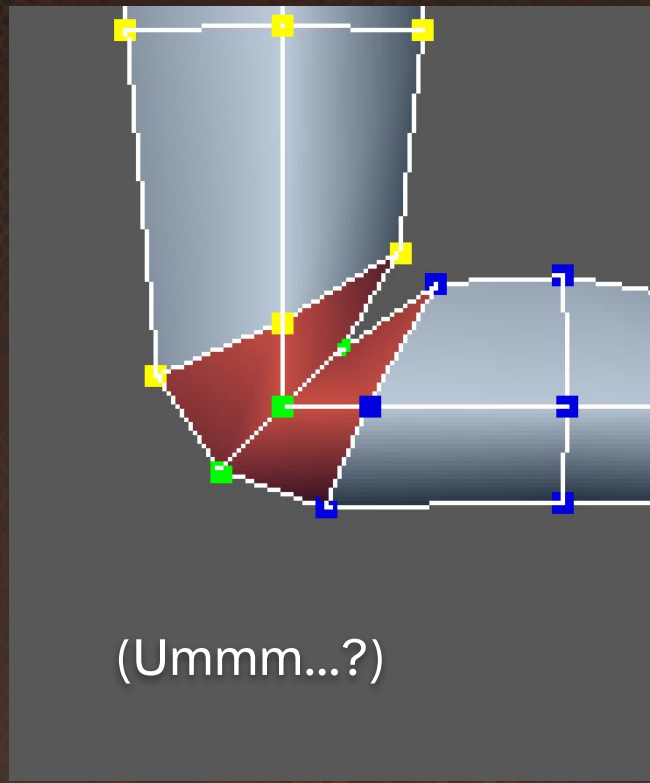
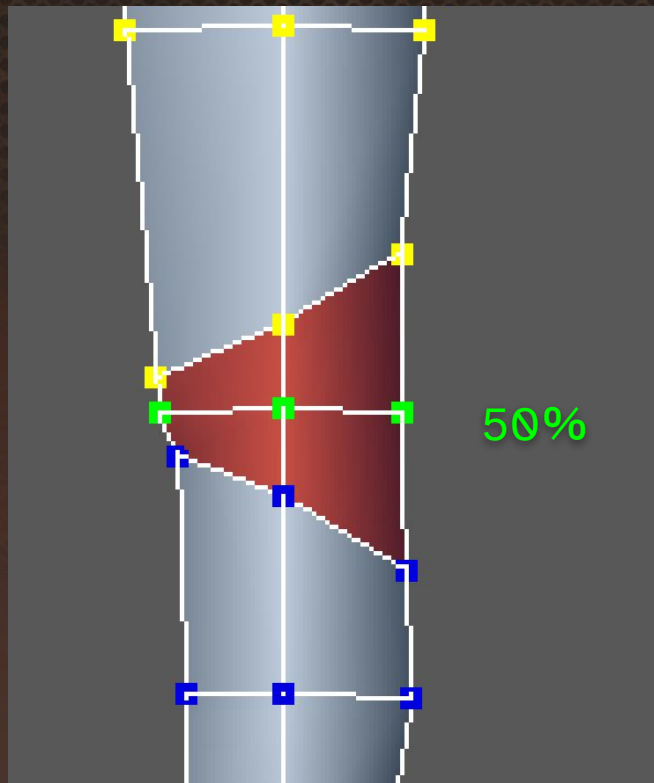
Joint Modeling : Common Mistake – The “50% Trap”

Ideal



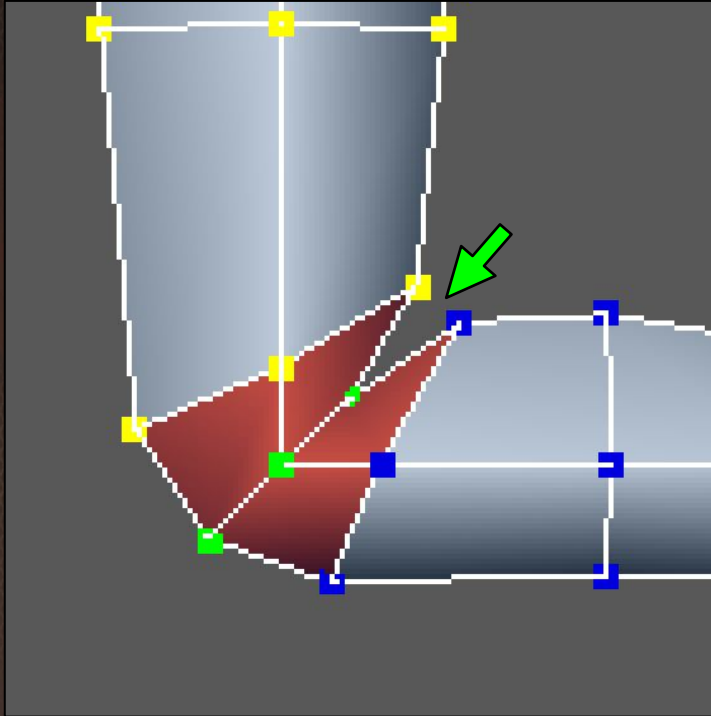
Joint Modeling : Common Mistake – The “50% Trap”

REALITY



Joint Modeling: Common Mistake – “The 50% Trap”

What went wrong?



⇒ The vertex of the back side of the knee, set at 50%, is somehow tucked inward. The joining area around the knee has become “thin”. What’s wrong?

⇒ The human body is full of stuff inside it. The joints don’t become thin even if bent.

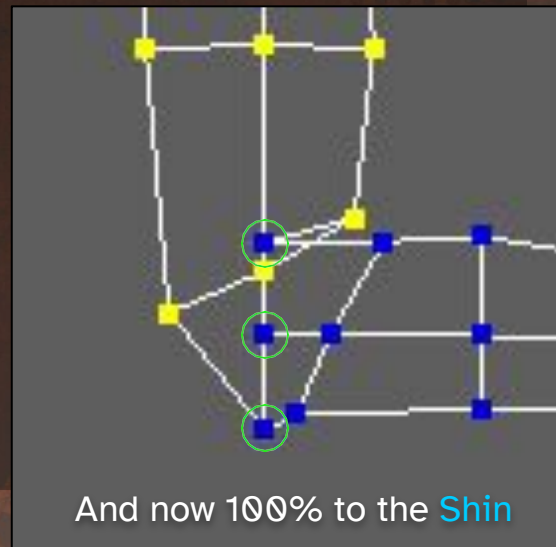
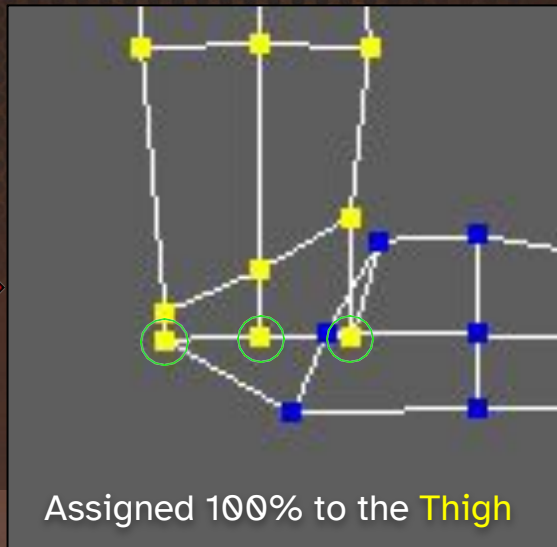
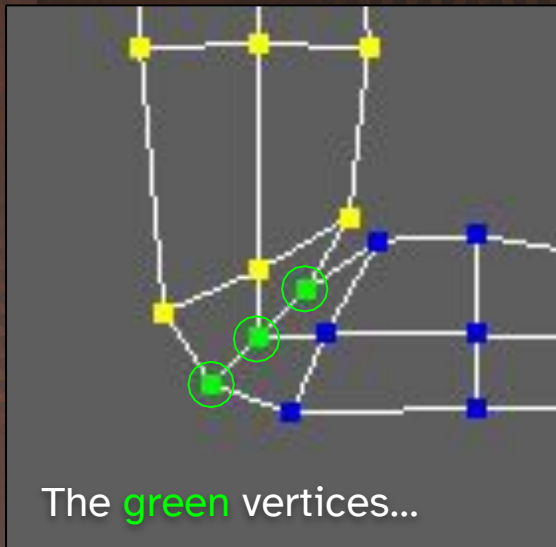
Only if you bend an empty thing, such as a rubber hose, will it behave like this.

⇒ If a joint becomes thin when bent, it’s disconcerting, as it doesn’t behave like a human body.

What's happening behind the weight blending

⇒ Let's try a simple experiment to understand why the joint became thinner.

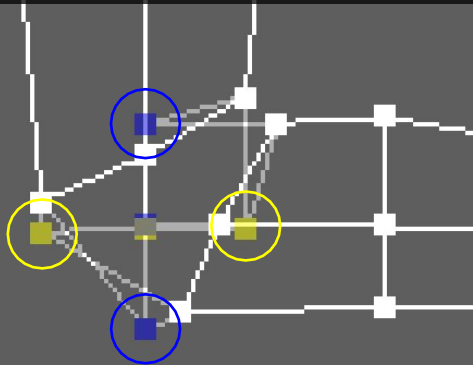
⇒ Taking a screenshot when 100% of the weight of the vertex is assigned to the thigh and the shin, respectively.



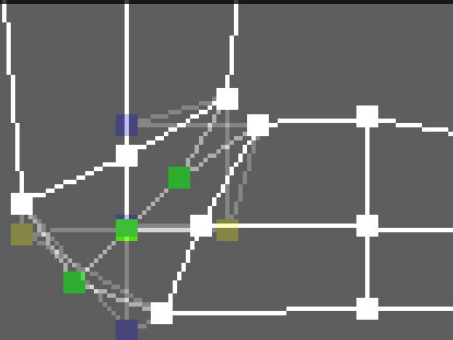
What's happening behind the weight blending

100% Thighs & 100% Shins

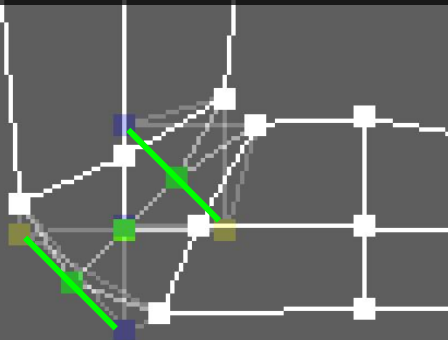
If you look at the screenshots superimposed on each other...



Then overlay the results of our 50% weight...



And connect the resulting positions with a straight line...

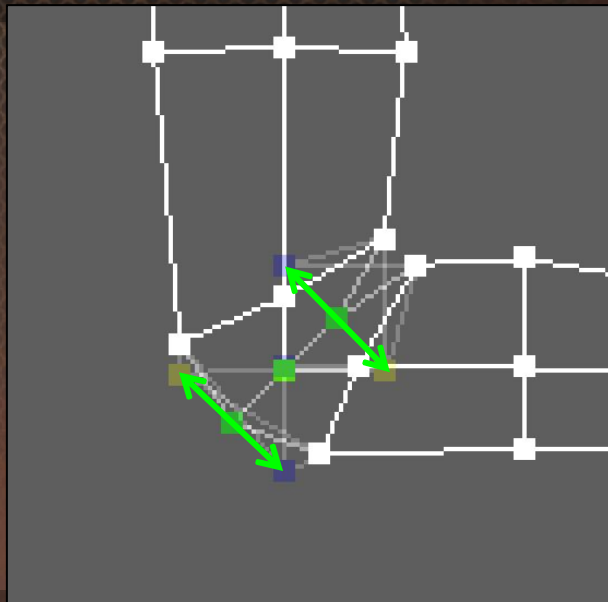


⇒ If you superimpose both the images of the 100% weights on the thighs and on the shins, and then our first result at 50% of both, you will find interesting things.

⇒ The position of our 50% Weight is right in the middle of both, connected by a straight line.

What's happening behind the weight blending

The 50% Trap.



DEMO

⇒ The **blending of all the weighted bones** is what results in this deformation.

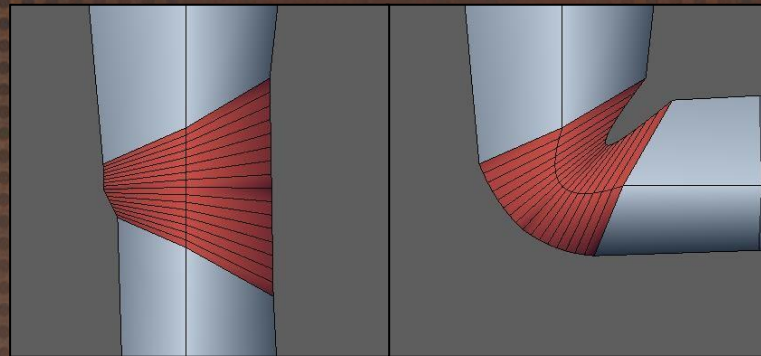
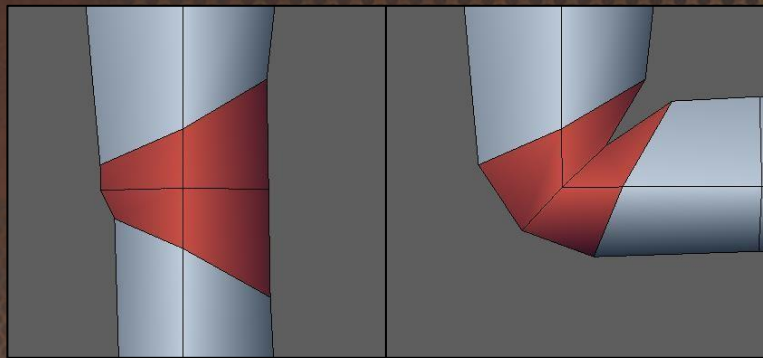
⇒ Even if you try other blend ratios, such as 25:75, it will just move the green line in the figure above.

→ **No matter what value you blend, it will inevitably become thinner.**

What's happening behind the weight blending

As far as I know, the calculation method for skinning is the same in all 3D softwares and game engines.

(There are other calculation methods, such as double quaternions, but they are not common.)



⇒ Increasing the subdivisions or smoothing out the weights **will not solve the root problem.**

→ In fact, it may even make it worse!

What's happening behind the weight blending

Conclusion

⇒ Weighted blending and rotation will inevitably result in a thinner mesh, due to the method of calculation. **No amount of tinkering with the skinning values will solve this problem.**

→ To solve this problem, we need a different approach.

⇒ If you understand the theory behind skinning, you can predict the result of the deformations to some extent just from the positions of vertices and weights.

→ You can see what kind of vertex arrangement and weight settings should be done to obtain the desired deformation result.

→ This leads to more efficient and better work.

Part3

Modeling for Better Joint Deformations

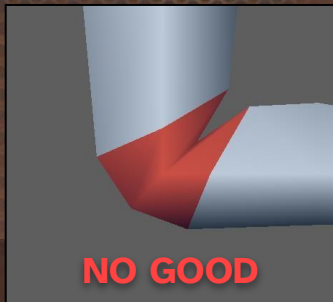
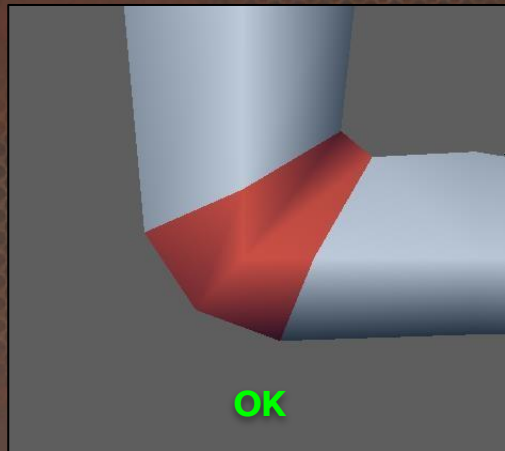


TIPS: "Standard" Topology for Clean Deformation

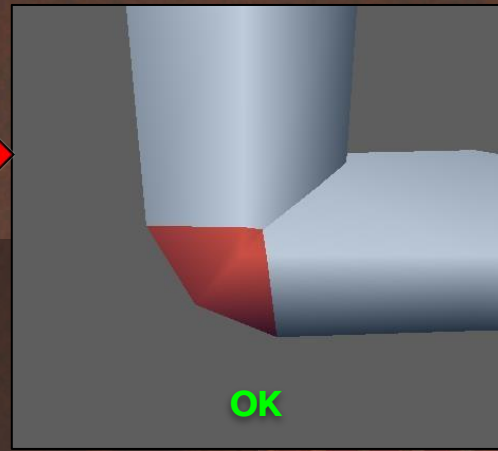
⇒ **The problems of skinning cannot be solved by skinning!**

⇒ When it comes to skinning, you need a different approach. One of them is modeling.

⇒ The problem of "thin joints" can be avoided by **planning out the vertex arrangement** of the mesh in the joints.
And there is more than one way to do this.



There are several
workarounds

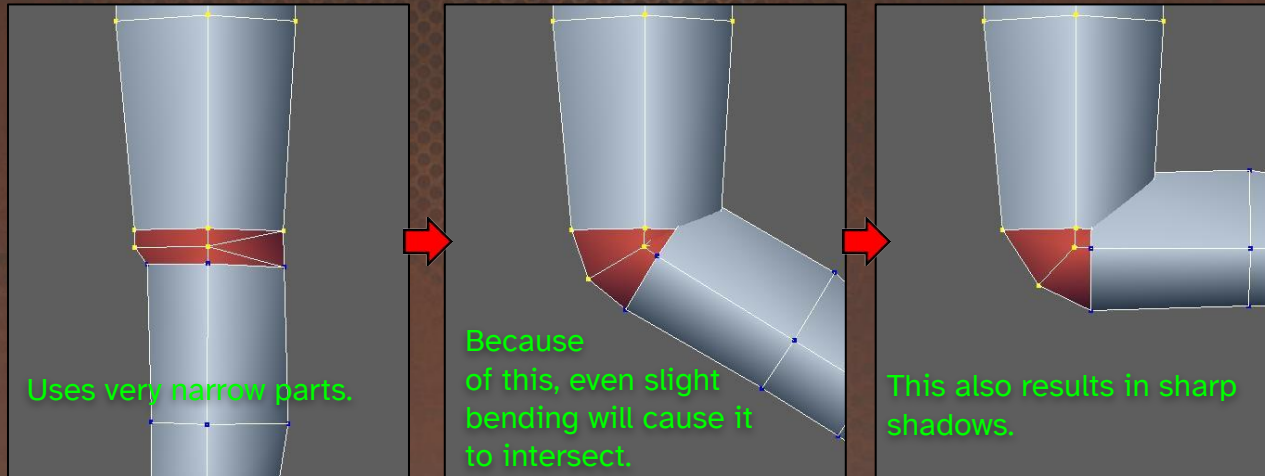


TIPS: Standard #1: The “Tuck-in” Structure

⇒ No Vertices placed at the halfway point of the back of the knee, where 50% of the weight of the thighs and shins lands. As soon as the joint starts to bend, the meshes overlap.

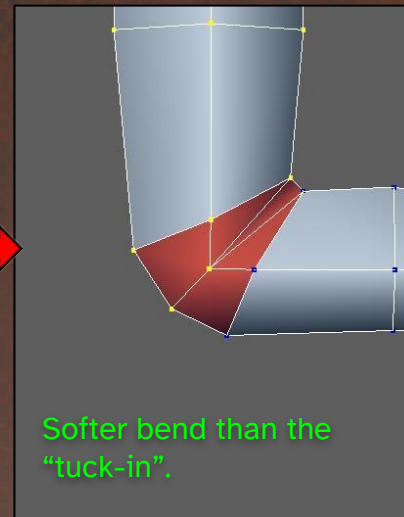
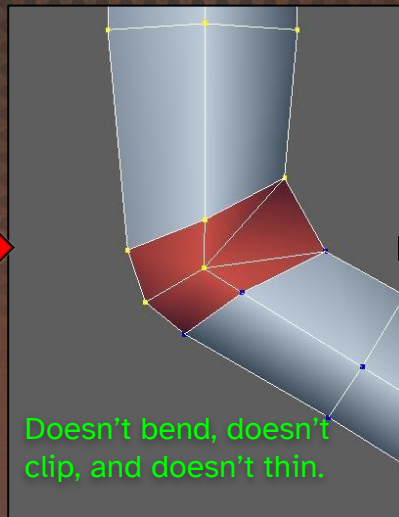
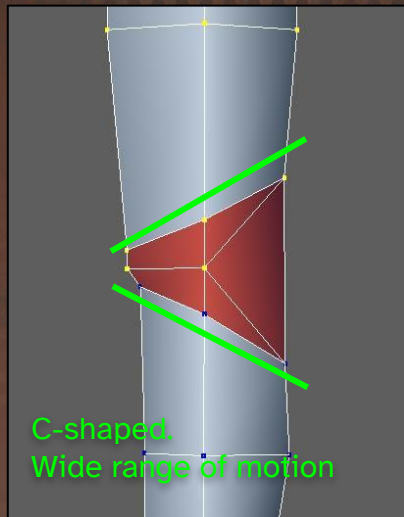
⇒ It is better to make it thin, rather than merged.

⇒ The sharp shadows at the intersection can contribute to the final expression.



TIPS: Standard #2: The “C” Structure

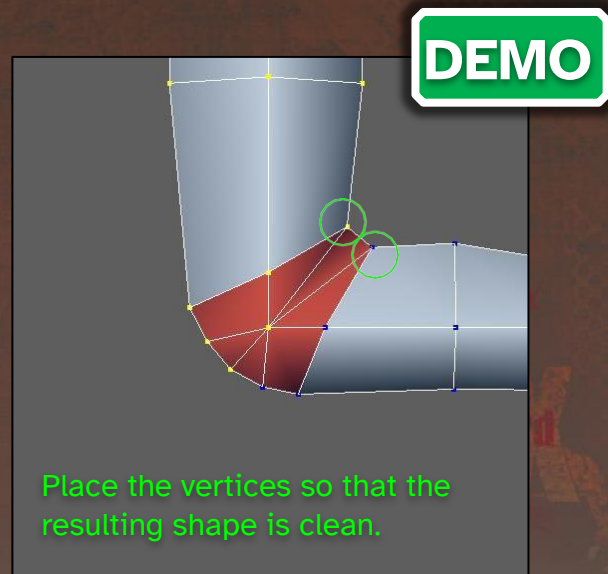
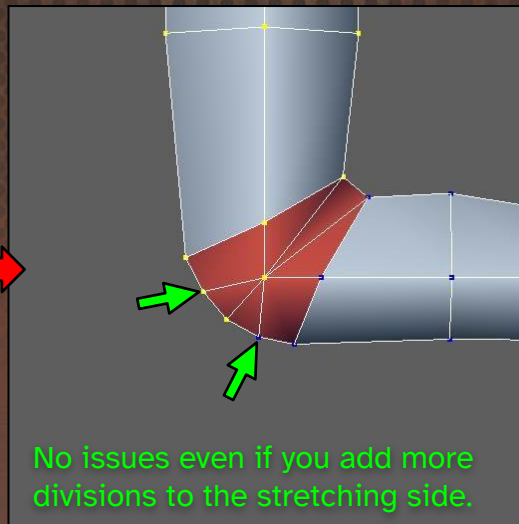
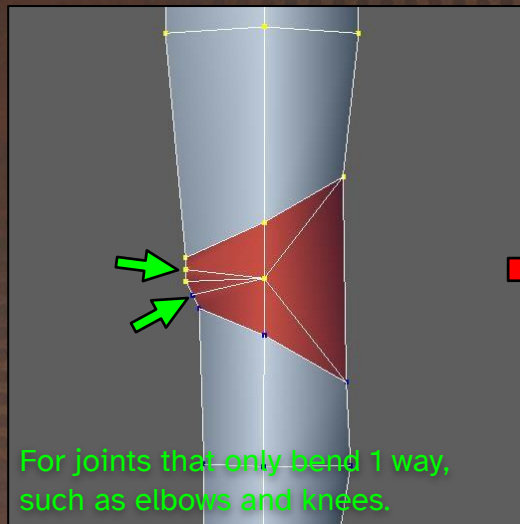
- ⇒ Same as before, no vertex is placed in the middle of the back of the knee.
- ⇒ Has a wide range of motion and is shaped like the letter “C”.
- ⇒ It does not become thinner when bent, but rather thicker, depending on the angle.
- ⇒ The final look of the bend is a little softer than the previous example.



※When bending further, clipping will occur, same as the previous example.

Common features of each arrangement

- ⇒ Increasing the number of polygons on the stretching side (kneecap) is OK.
- ⇒ Do not unnecessarily increase the number of segments on the shrinking size (back of the knee).
- ⇒ Place vertices in a way that results in a clean shape, thinking backwards from the resulting deformed shape.



Part4

“Bone Placement” & “Modeling”



TIPS : Model while thinking of joints.

- ⇒ Be aware of parts that will be bent by the joints, and parts that won't, from the beginning of the modeling stage.
- ⇒ Parts that will move are modeled to avoid collapsing into themselves, conscious of the “50% Trap”.
- ⇒ Even in an extreme case, with all weights at 100%, a basic silhouette can still be created.

DEMO

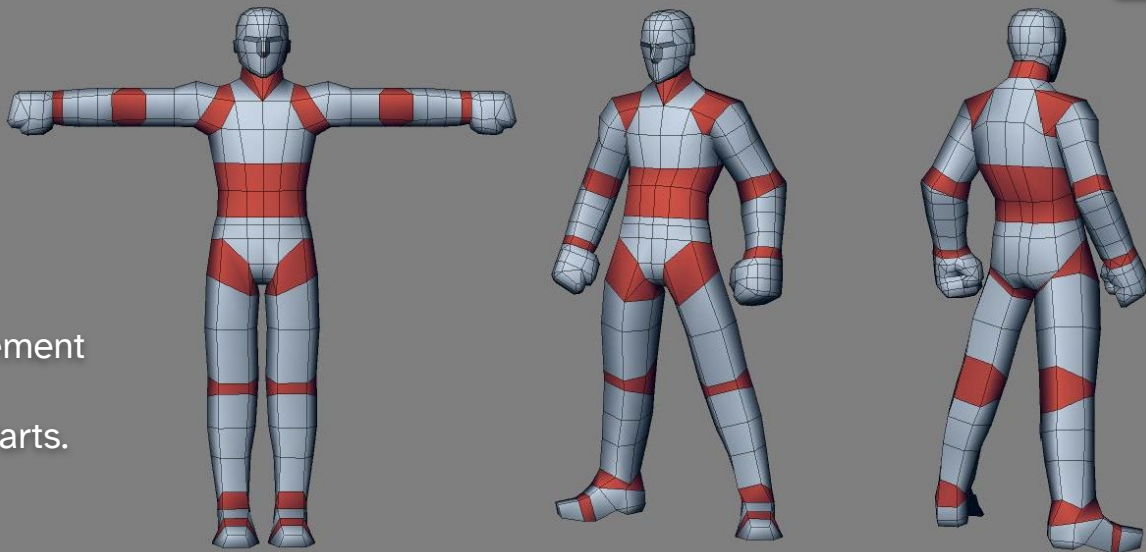
Example:



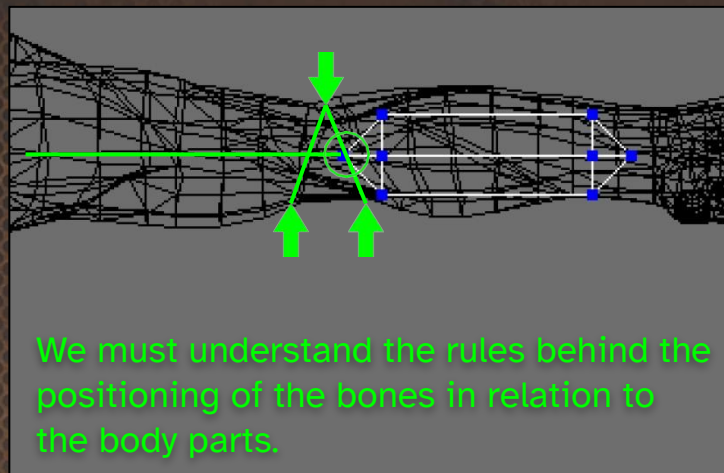
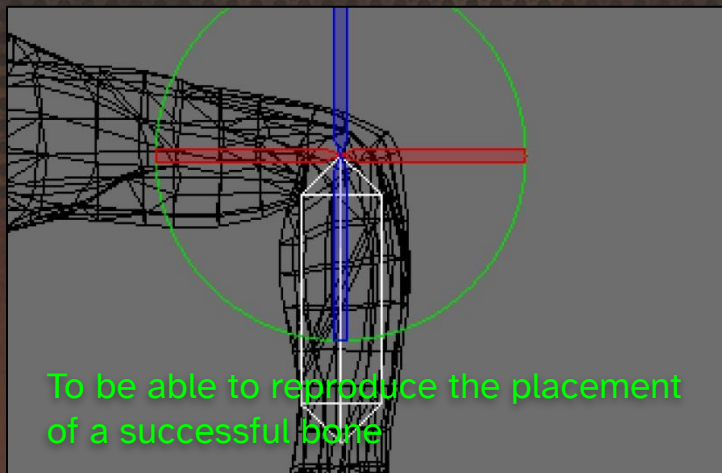
Gray: No Movement



Red: Moving Parts.



TIPS : Place the bones in the best position.



⇒ Many skinning issues are caused by incorrectly-placed bones.

⇒ No matter how much you adjust the skinning values, you will never be able to fix the problem if the bones are badly positioned.

⇒ First, you need you to learn the structure of the human body. Learn by working while checking books and other materials.

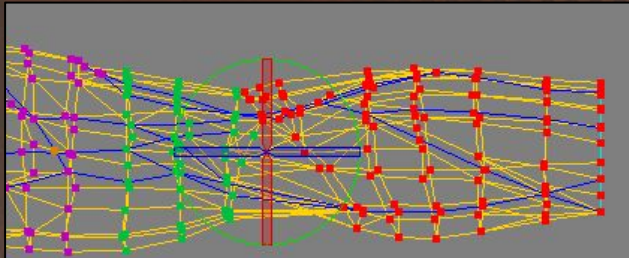
⇒ Remember the rules of placement when it goes well, and try to accumulate knowledge.

TIPS: Techniques to find good bone placements #1

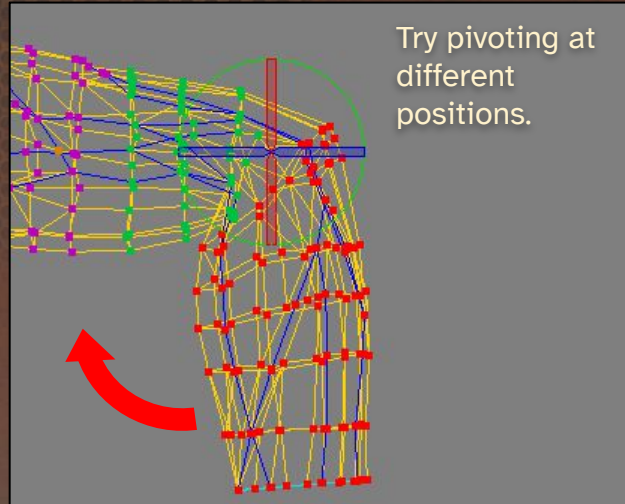
Let's try bending it by deforming the mesh.

DEMO

- I recommend you try to bend the mesh by using the rotation of the modelling tool, instead of the bone.
- Place the pivot of the rotation tool on the provisional rotation axis and try to bend it.
- Place the pivot in several places and bend it to find a good spot.
- When you find a good spot, place the bone there. (Restore your mesh with Undo first)



Select the vertices, then place the rotation tool where you want to test the axis position.



Try pivoting at different positions.



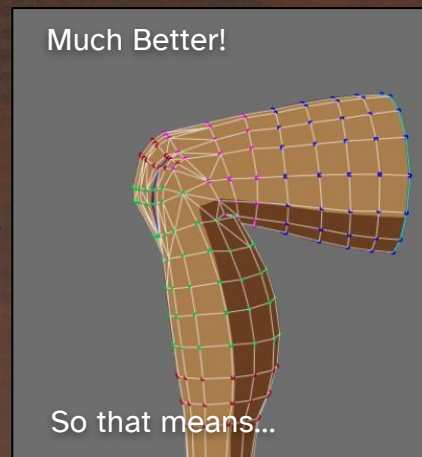
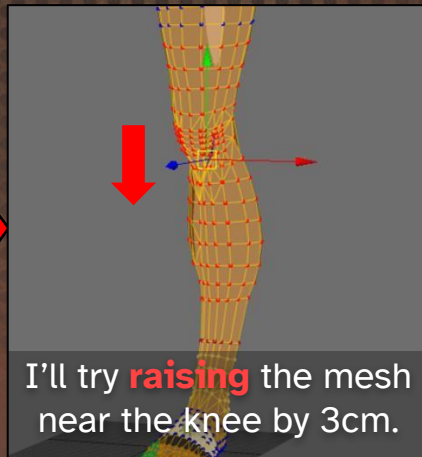
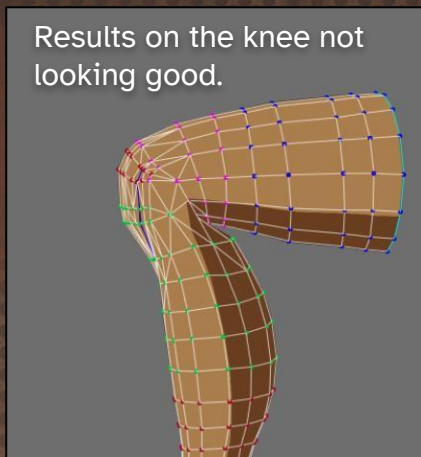
When you find a clean deformation, place the bone there and you're OK to go!

TIPS: Techniques to find good bone placements #2

Move the mesh to find the best position.

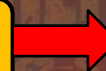
DEMO

- Shift the position of the mesh at the joint to find something that suits the deformation.
- **Undo** the movement of the mesh and shift the bone **the opposite way** by the same amount.



The proper position for the knee was 「3cm

LOWER」!



Just reposition the bones there and you're OK!

Part5

Other Skinning Tips

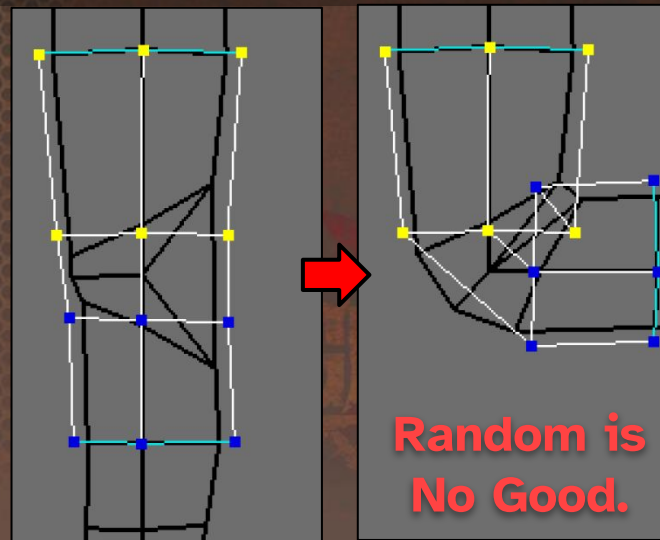
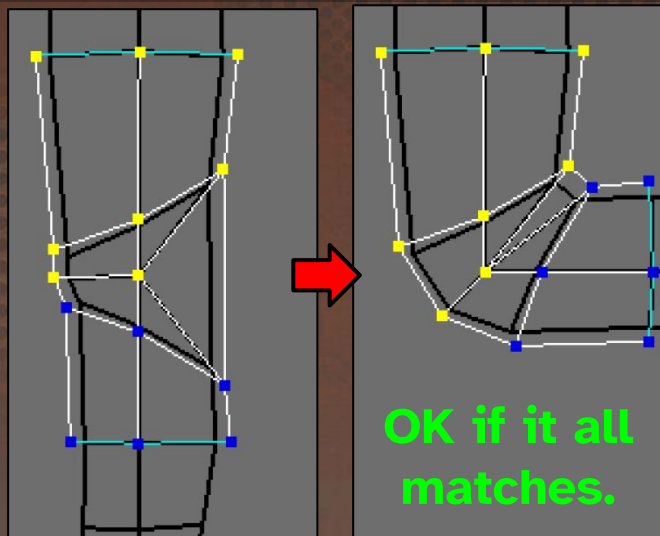


Use the same topology and weights for “layered” meshes.

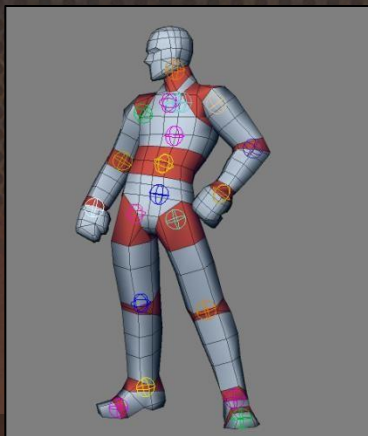
⇒ If you have a multi layered design with clothes and decorations on the body, **make sure the vertex placements and weight settings match between elements.**

⇒ If not, the layered elements will clip or stick out when the pose changes. This is completely a modelling issue.

⇒ Remember that **vertices with the same position and weight will always be in the same position after deformation**, and use it.



Do several poses to check



⇒ Once you've made some progress with the skinning, pose your model in a variety of ways.

⇒ To check the silhouette, do some preliminary skinning before completing the mesh.

⇒ Test with animations that you'll actually use in the final work.

(For example, if you're working on a fighting game, punches and kicks, but also celebrating, doing the splits, etc.)

⇒ Test this before handing the model over to the animator, so you don't have to worry about it afterwards.

→ This is because, as I explained before, problems usually arise from the mesh.

Part6

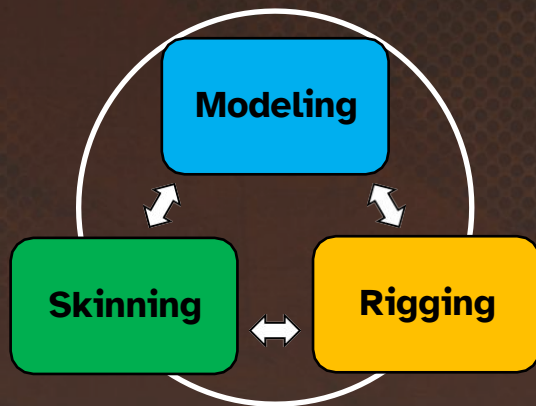
EXTRA - A Basic Introduction to Rigging



The next step is rigging!

- ⇒ So far, I've talked about how to solve the skinning problems with modeling.
- ⇒ However, there are some problems that cannot be solved by modeling alone.
- ⇒ Rigging is necessary in such cases.

⇒ When you have a working trinity of Modeling, Skinning and Rigging, you will have the conditions for a character model that looks and moves cool.

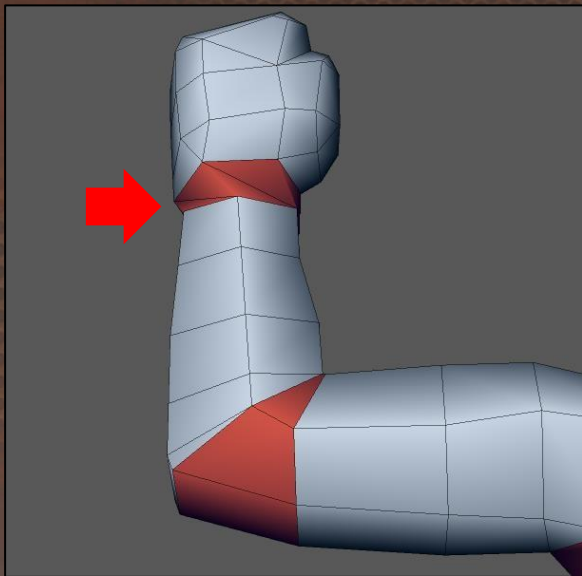


**It moves
COOL!**

Basic Introduction to Rigging: Wrist Twist #1

⇒ It's hard to start with an advanced rig suddenly, so let's start with a simple challenge.

⇒ Controlling the twist of the wrist is relatively simple but has a wide range of applications.

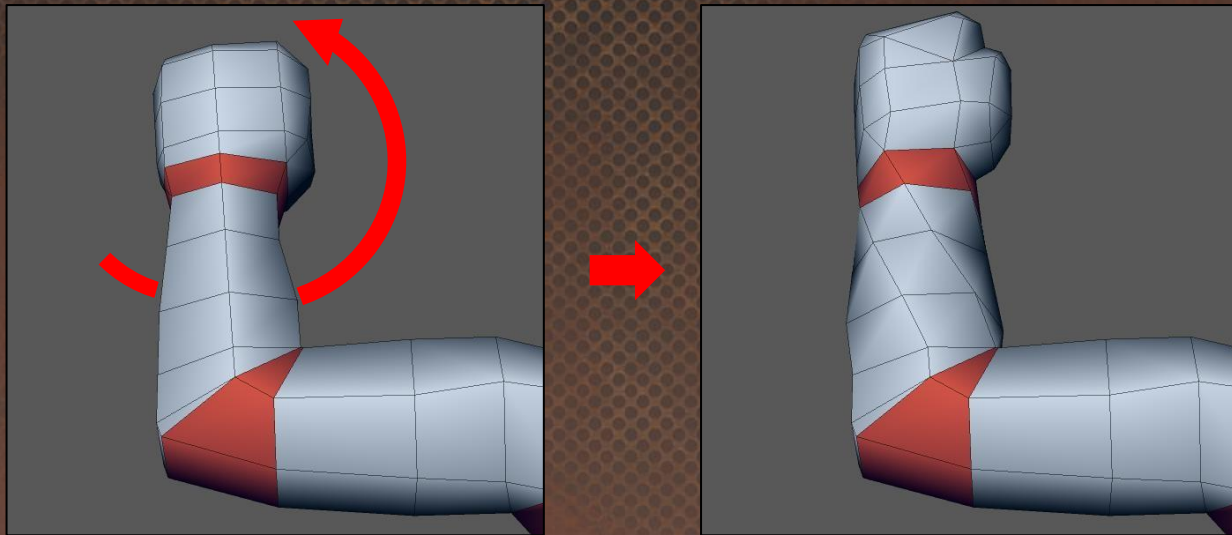


→ If you do nothing, when the wrist rotates, the joint collapses.

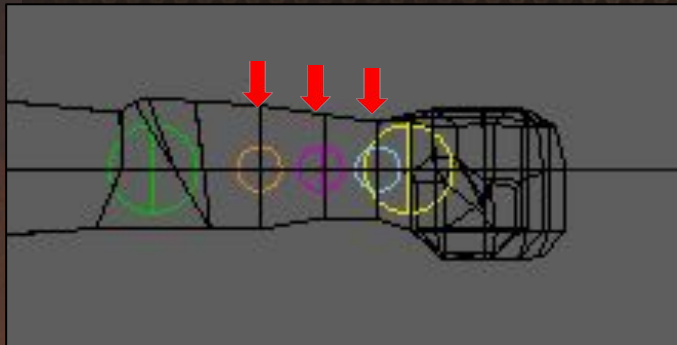
I want to solve this.

Basic Introduction to Rigging: Wrist Twist #2

⇒ In the actual human body, **the whole forearm gradually twists**, from wrist to elbow.



Basic Introduction to Rigging: Wrist Twist #3

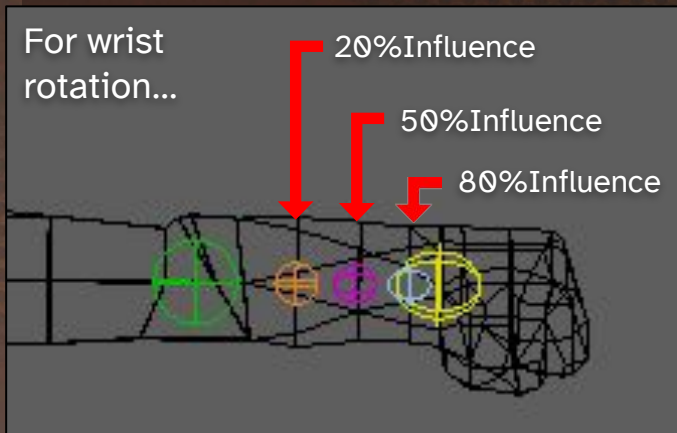


⇒ Place multiple twisting bones inside the forearm and rotate them gradually alongside the wrist bones.

⇒ Depending on the 3D software, the way to do this varies, including constraints, expressions, node controls, etc. So you should investigate on your own.

⇒ It is useful for solving “twisting” problems in all parts of the body, not just the wrist.

⇒ It’s a great way to practice your rigging skills, and its applications are wide, so it’s a very “cost-effective” thing to practice. Recommended!



DEMO

Why modelers should learn how to rig

⇒ There are many problems that often cannot be solved by modeling or skinning, but can be solved by rigging.

⇒ You must model while thinking of how it will be rigged.

“This vertex moves like this depending on the rig, so it’s placed correctly.”

⇒ It is ideal to be able to model while thinking backwards from how each vertex will be controlled by skinning and rigging. (Unique to Low-Poly)

⇒ Character modelers should learn not only how to create meshes, but also study skinning and rigging, in order to improve the quality of the final character model.

⇒ Learn a lot and increase your overall strength as a character modeler!

Lastly



Lastly

Summary:

⇒The Root of the problem may lie elsewhere. Try not to get too caught up in the “means” in front of you. Problems you can’t solve no matter how hard you try sometimes need a different approach.

⇒If you understand what is happening “behind the scenes” of the process, it will be easier to identify the cause of the issue, and you will be able to see the solution.

⇒You may be able to “skip” issues by learning new means.
→For Example: An Intro to rigging.

⇒There should be a solution or workaround for any problem. Continued pursuit can lead to unexpected discoveries, deeper insights and radical solutions.

Don’t give up, think hard, try various things and make mistakes.

Staff Recruitment Info

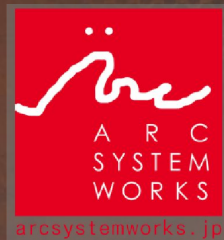
I want to work on models that look like this!

I want to animate models that look like this!

I want to make backgrounds!

I want to make effects!

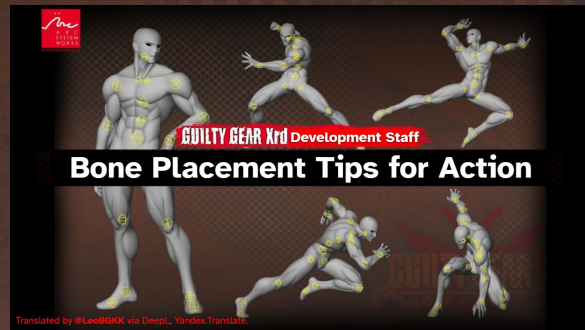
Come to Arc System Works!



MORE INFO

<https://www.arcsystemworks.jp/official/company/whatisarc/>

Other GGXrd 3D Materials



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